Where are innovation indicators, and their applications, going?

UNU-MERIT Working Paper Series

#2014-055

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Fred Gault

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

UNU-MERIT Working Papers

ISSN 1871-9872

Maastricht Economic and social Research Institute on Innovation and Technology, UNU-MERIT

Maastricht Graduate School of Governance MGSoG

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Fred Gault
gault@merit.unu.edu

UNU-MERIT, Maastricht, the Netherlands
and the Tshwane University of Technology (TUT)
Institute for Economic Research on Innovation (IERI), Tshwane, South Africa

Abstract
This paper reviews the current state of indicators of the activity of innovation and how they are presented for use in the policy process leading to a discussion of the development of new indicators, some outside of the business sector, which raises questions about the definition of innovation. This is followed by a review of plans for the evolution of innovation indicators and their use over the next few years. These plans, national and international, are diverse and this leads to a discussion of international organizations and forums which could facilitate progress towards new indicators and a better understanding of innovation systems.

JEL Codes
O30, O31, O35, O38, Z18
Key words
Innovation indicators, definitions of innovation, development of innovation indicators

September 2014

1. Introduction

This paper explores the future development of innovation indicators and their applications. It is written at a time when there is much discussion of what indicators mean and how they can be used to support public policy.

Within the Organisation for Economic Cooperation and Development (OECD) community, the Frascati Manual (OECD 2002), which provides guidelines for the collection and interpretation of research and development (R&D) data, is undergoing its sixth revision since its publication in 1963. That will be followed by the third revision of the Oslo Manual (OECD/Eurostat 2005) which deals with innovation data and indicators. In the European Union, the European Commission has introduced a new 'headline indicator' for innovation (EC 2013). Within the Ibero-American Network of Science and Technology Indicators (RICYT) community, the Bogota Manual (RICYT/OEC/CYTED 2001), that deals with innovation, is under revision.

While innovation indicators have been in use for decades and the collection and interpretation of the data needed for them was first codified over 20 years ago (OECD 1992), the subject is broadening. Researchers are studying innovation resulting from emerging technologies, being detected in foresight studies, and appearing in the activities of users of technologies and practices.

In addition to the indicators that conform to the definitions in the Oslo Manual, there are communities working on innovation in the public sector, as well as consumer innovation and social innovation. This challenges existing definitions and raises questions about how a broader view of innovation could be accommodated.

The paper builds on Gault (2011a) which discussed the social impact of indicators and the importance of definitions, common language, and the ongoing tension between tacit and codified knowledge, which influences the revision process of manuals. That paper also supported proposals for an academic subject devoted to the science of innovation policy (Gault 2011b).

Many of the examples used here are drawn from Gault (2013) which also provides an extensive bibliography and a more detailed discussion of the future of indicators of science and technology and of innovation.

2. Innovation indicators now

Indicators provide an indication of the state of a system or of its change. They are used to monitor the system, to benchmark one system against another, and to evaluate the consequences of intervention. They can also support foresight analysis and research into indicator development. They and their development can be influenced by the users of the

indicators (Gault 2011a). Indicators are statistics, or a combination of statistics, populated by data and the data can come from a variety of sources including surveys and administrative data.

As discussed in Gault (2011a), the system of national accounts (SNA) provides an excellent example of a set of indicators being used to describe the state of a system and its change over time. Gross domestic product (GDP), the change of GDP over time and GDP/capita are used extensively in public policy debate and these, and other SNA indicators, are part of the common language supported by a manual with concepts and definitions (EC et al. 2009) which is regularly updated.

Innovation, and indicators to describe the activity of innovation, are not part of the common language and not all researchers use the same definition for innovation, making it impossible in some cases to make comparisons or to have meaningful discussion. The development of innovation indicators is still very much an evolving subject, which makes understanding that development an important objective for users and producers of the indicators and the definitions that underlie them.

Within the OECD community of 34 member countries, the European Commission, candidate and observer countries, the definition of innovation, for measurement purposes, is taken from the Oslo Manual, paragraphs 146 and 150 (OECD/Eurostat 2005), and it can be paraphrased as innovation is the bringing of a new or significantly improved product (good or service) to market or finding a better way of getting a product to market. The definition includes three ways of getting the product to market: the transformation of inputs to outputs and delivery of the outputs; organizational change or change in the use of business practices; or, market development or the finding of new markets. All three are process activities but the earlier literature on innovation focused on the first one as 'process' innovation.

With the Oslo definition, innovation can only happen as a result of a product being placed on the market. The agent placing the product is a firm and the basic indicator, gathered by decades of innovation surveys[1], is the propensity of the firm to innovate. This is quite different from R&D indicators where the indicator is not the propensity to do R&D but the expenditure on the performance of R&D, or the human resources allocated to the performance of R&D. Were the propensity to do R&D an indicator for business R&D, it would be quite small as R&D is a rare event and it is highly concentrated in a few countries and in those countries in a few industries and in those industries, in a few firms. Innovation, by contrast, is more widely distributed as more firms innovate than do R&D (OECD 2009).

[1] See http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis for EU Community Innovation Survey (CIS) questionnaires.

In CIS questionnaires, there is a question about expenditure on innovation activities, but the innovation activities are not linked to the activity of innovation. They provide information on what the firm is spending in support of innovation but not necessarily what it has actually spent on innovation. While the data are difficult to collect, the resulting information has a place in the production of innovation indicators. Part of the reason for this is that innovation and R&D, which is but one of many innovation activities, are linked, especially in large firms. However, causality, or its direction, cannot be established from repeated cross-sectional surveys.

A characteristic of innovation, as defined in the Oslo Manual, is that it can be influenced in two domains: within the firm; and, outside the firm. Innovation in the firm can be stimulated by direct interventions such as contracts or grants to support the performance of R&D, capital expenditure in specified areas such as information and communication technologies (ICTs), or training and development of staff. This could be part of industrial, sectoral, or regional policy. An example of indirect support is a tax programme to encourage R&D or capital expenditure. Tax programmes tend not to be confined to a sector.

While innovation takes place within the firm, it is influenced by external policies most of which are not seen as innovation policies. Some of these are government regulations, financial markets, trade rules, intellectual property policy, and policies related to physical and social infrastructure. Any of these can be changed by the government of the day, but there are other external conditions (boundary conditions, institutions, rules of the game, …) that evolve over decades dealing with culture, education and health. These take longer to change.

The breadth of the influences on the activity of innovation, directed at the firm or acting as boundary conditions which indirectly act on the firm requires a systems approach if indicators are to be developed to support the understanding of innovation or of the innovation system. Simply put (Gault 2010), the system consists of actors, or economic agents, that engage in activities and link to other actors, leading to outcomes in the short term and impacts in the longer term. The actors include businesses, governments, education, health and research institutions and foreign institutions. Example activities are R&D, invention, diffusion of technologies and practices, design, and human resource development. Then come the linkages which include one or two way flows of data, information, knowledge, energy, materiel, and people. The result, in the short term, of innovation in this system may be jobs and growth and productivity and, in the longer term, wellbeing, cultural change and global influence. However, none of this is guaranteed as demonstrated by innovation in financial services in the U.S. in 2006-2007 which resulted in a world-wide financial crisis of 2008.

Indicators for an innovation system have to cover the propensity to innovate, to engage in innovation activities, and to interact with other actors in the system through contracts, grants, loans, collaborations, co-publication or co-patenting, human resource mobility,

… The measure of linkages is a key part of understanding how the system is working and where the problems lie, problems that could be addressed by innovation policy or indirectly by other policies.

Innovation policy is not a simple process as the innovation system that the policy, once implemented, tries to influence is dynamic, complex, non-linear in response to interventions and global. Understanding the system is difficult, but there must be some understanding if innovation policy is to work, where 'work' refers to achieving the short and longer term objectives mentioned earlier, and having (desired) social impact (Gault 2011a).

Indicators of activities and linkages permit monitoring of the innovation system and evaluation of policy interventions, leading to policy learning from success or failure, public policy debate and adjustment of interventions. Measurement and resulting indicators become part of a learning system which, over time, ideally, becomes more effective at improving outcomes. It is the systems approach that, so far, has distinguished innovation from R&D policy. With R&D policy there have been direct and indirect interventions to change the behaviour of the actors. There has been some interest in sources of funding and of human resources for the activity (linkages), but limited effort towards producing indicators for the whole R&D system (actors, activities, R&D in this case, linkages, outcomes and impacts). Innovation policy, because of the connected nature of the activity, must take a systems approach and, as a consequence, requires a wider range of indicators.

3. Presenting indicators of innovation and using them

For innovation indicators to contribute to public policy discourse, they must be put in the public domain and the organizations doing this must have legitimacy in the community being served by the indicators (Davis et al. 2012). Many countries produce national indicators of innovation which may have indicators of activities related to innovation, such as publication statistics (bibliometrics), patent statistics, R&D, capital expenditure in key areas, such as ICTs, and training and development of the labour force related to innovation. There may be a focus on a technology and a technology innovation system, on a region, or on a sector. There are also organizations publishing international statistics related to innovation.

Examples of national statistics are found in reports of the Observatory of Science and Technology in Columbia (http://ocyt.org.co/es-es/InformeAnualIndicadores), the State of the Nation Report of the Science, Technology and Innovation Council (STIC) in Canada (http://www.stic-csti.ca/eic/site/stic-csti.nsf/eng/h_00058.html), the indicators reports of the National Science Foundation in the US (http://www.nsf.gov/statistics/seind14/), the Observatoire des Sciences et des Techniques in France (http://www.obs-ost.fr/), and the Federal Ministry of Education and Research in Germany (www.bmbf.de/de/22744.php). International statistics are

published by RICYT for Latin America and the Caribbean (http://www.ricyt.org/indicadores), NEPAD for Africa (AU-NEPAD 2010, 2014), the European Commission (http://ec.europa.eu/enterprise/policies/innovation/files/ius/ius-2014_en.pdf), the OECD (2012, 2013), the UNESCO Institute of Statistics (UIS)[2] and the World Economic Forum (http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf).

Once published, innovation indicators are used in many ways, not all intended by the producers of the indicators. An example of the use of indicators is the ratio of gross domestic product (GDP) devoted to the gross domestic expenditure on R&D (GERD), the GERD/GDP ratio. In the EU, a target, the Lisbon Target, has been set for this ratio of 3 per cent with 2 per cent coming from the business sector. This ensures that policy is more focused on R&D rather than on facilitating the development of new or significantly improved products and putting them on the market or finding better ways of getting products to market. The question for consideration is whether this is the appropriate policy balance to support jobs and growth and long-term improvement in wellbeing. Directly related is whether the development of innovation indicators described in this paper contributes to that discussion.

As mentioned, the EC has released an innovation headline indicator but it has yet to assign targets. The apparent lack of use of innovation indicators in policy has been reviewed by Arundel (2007) and Arundel et al. (2008). The concerns raised are still valid and present a real challenge to those developing and publishing innovation indicators.

4. Where are innovation indicators going?

There are two approaches to a discussion of the development of innovation indicators. The first deals with new indicators that are being developed within the concepts and definitions in the Oslo Manual and the second considers activities not governed by the existing Manual.

4.1 Indicators in the existing paradigm

Four examples are considered: user innovation in firms; emerging technologies and innovation; foresight as a means of anticipating the need for new indicators; and 'restricted' innovation.

Firms have two ways of becoming process innovators as defined in the Oslo Manual. The less demanding of the two is to acquire available technologies or practices and to use them. If these are new to the firm, the firm is a process innovator at the lowest level of innovation in the Oslo Manual, but it is not a user innovator. The more demanding approach is to change the process or practices of the firm for the benefit of the firm. The

[2] See Section 5.

firm, as a user, is changing processes for its own benefit. This can be done in two ways. The firm acquires technologies or practices and modifies them for its own benefit, or, in the absence of these technologies or practices on the market, the firm develops its own, again, for its own benefit. The firm is a user innovator. While there is an established literature on these activities (de Jong and von Hippel 2013), user innovation by firms is not seen explicitly in scoreboards or in policy intervention.

New technologies are emerging and they are not yet well enough established to support robust indicators that are internationally comparable. Using insights gained from the emergence of information and communication technologies (ICTs) research is being undertaken to find new indicators (Gokhberg et al. 2013) derived from measuring weak signals of activities now happening. Examples could be the use, or planned use, of nanotechnologies or new materials by firms.

Foresight analysis identifies trends in the development of new technologies and practices that are not yet happening. They can also suggest indicators that are needed to track the activities when they do happen (Meissner and Sokolov 2013). Anticipating cloud computing activities and their impacts could be an example.

So far, the three examples of innovation indicator development have worked within the existing restrictions of the Oslo Manual. However, the Oslo Manual is not very restrictive. For a new or significantly improved product to be an innovation it must be introduced to the market, but that is all. There is no requirement that the innovation be 'good' or lead to more jobs and economic growth. It can, in fact, lead to negative outcomes. In the fourth example, the definition of innovation is restricted to a specific population. Some examples of such a population are the poor, those at 'the bottom of the pyramid', or those considered to be 'grass roots' innovators. The restriction can also be imposed on the outcome of the innovation and the example that will be used is the definition of Mashelkar (2012) of inclusive innovation for sustainable development. The definition adds two time scales, with measurement implications, to the one already used in the implementation of the Oslo Manual definition in surveys, the three years period including the reference year and the two years prior.

The Mashelkar definition is the following:

> Inclusive innovation is any innovation that leads to affordable access of quality goods and services creating livelihood opportunities for the excluded population, primarily at the base of the pyramid and on a long term sustainable basis with a significant outreach (Mashelkar 2012).

The definition restricts the innovation to a subset of those that satisfy the Oslo Manual definition and which refers to activity of the firm in the last three years. Inclusive innovation restricts the innovations to those that lead to 'affordable access of quality goods and services creating livelihood opportunities for the excluded population'. To know that the innovation belongs in this category, there must be a measurement at some

time after the good or service has been introduced to the market to demonstrate it is affordable, it meets a 'quality' standard, and it creates livelihood opportunities for the excluded population. Once that is done, the innovations that have satisfied these criteria must be shown to have met these criteria on a long term basis.

Inclusive innovation for sustainable development is an important subject, especially in developing countries. The strength of the Mashelkar definition is that it can be operationalized but the implementation of the definition through statistical measurement requires three time scales: the previous three years for the innovator; a medium term measurement, perhaps through a social survey, to confirm that the criteria in the definition have been met; and, a longer term measurement to confirm sustainability. This presupposes a working definition of 'sustainability' All of this is possible, but it requires longitudinal analysis of activities in firms, and in the excluded population. The question arising is whether, in the view of a government, addressing these social issues is sufficiently important to justify the cost of developing the indicators needed to inform the policy debate and to monitor and evaluate policy once it is implemented.

4.2 Broadening the paradigm

A key point about innovation is that the new or significantly improved product must be delivered to the market and new or significantly improved processes (broadly defined) are better ways of getting product to market. The market is the means for potential diffusion of the innovation (product) or the effects of better ways of getting product to market (processes). Note that the market is a 'potential' means. The firm could go bankrupt and never sell the product or realize the benefit of getting product to market in better ways. All the firm has to do is deliver the product to market, or to use new or significantly improved processes to get it there. Note also that the market consists of potential users of the product or of the benefits derived from the processes.

These considerations are important when looking at public sector innovation where there is no market, but there are potential users. A public institution can engage in all of the innovation activities that a firm uses. The only difference is the delivery to the market (Bloch 2013). Consumers, as with firms, can modify goods or services for their own use, or create them (de Jong and von Hippel 2013). Firms that do this qualify as innovators, but not consumers according to the present Oslo definition. However, there may be a way to resolve this.

Public sector organizations and consumers could be admitted to the class of innovators if paragraph 150 of the Oslo Manual was modified to replace 'on the market' with 'to potential users' (Gault 2012). Were this, or a similar modification adopted in the next revision of the Oslo Manual, the Oslo Manual framework could be applied to the public sector and to consumers, perhaps giving rise to an Oslo family of manuals dealing with the characteristics of each area, just as the current Oslo Manual deals with the firm. Making this happen is a matter for the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) as it sets the standards for measurement of

innovation in OECD and EU countries, standards which are adopted in other countries such as China and member countries of the African Union.

Public sector institutions and consumers satisfy the proposed definition for the purpose of gathering innovation statistics. There are cases where the unit of observation becomes more problematic and examples are ‘social innovation’ and innovation in the informal sector. In the case of ‘social innovation’ communities may change technologies or practices for their own benefit, but this is an evolving field (Mulgan et al. 2013). Also, social innovation can overlap with other kinds of innovation, such as grass roots innovation (Letty et al. 2012). There is a place for case studies and analysis of these areas to gather information needed to support work on definitions, measurement and the production of data needed for new indicators of innovation.

In developing countries, the informal sector is responsible for a substantial amount of economic and social activity and it is also a place where there is innovation of various kinds. Understanding innovation in the informal sector is a challenge for statisticians and analysts and then for policy makers trying to change things. However, the informal sector is difficult to measure (Konté and Ndong 2012) and will remain a challenge for indicator development for some time.

5. Agendas

Going back to Gault (2011a), work on definitions, language and implementation of definitions through measurement activities are ongoing activities.

At the OECD, the Frascati Manual (OECD 2002) which deals with R&D is under revision. This is a major revision as R&D statistics and indicators are no longer focused just on the performance of R&D by organizations and the allocation of financial and human resources to support this. R&D is a global activity and there are value chains to be accounted for as well as the flows of knowledge, finance and people into and out of the organizations that perform R&D. In addition, R&D was capitalized in the SNA 2008 and is no longer an expense. As a result, dealing with R&D involves the national accounts, trade statistics, and outsourcing and insourcing measures, both domestic and international. This revision process, while important in its own right, is also a preparation of the indicator community for the revision of the Oslo Manual.

The third revision of the Oslo Manual is expected to start in 2015, and the OECD Blue Sky III conference is planned for 2016. This conference happens every decade and covers all indicators related to science and technology and innovation. The results of Blue Sky III will influence the Oslo revision, just as Blue Sky II in 2006 (OECD 2007) influenced the OECD Innovation Strategy (2010a), the related measurement strategy (2010b), and the micro-data analysis of innovation in firms (OECD 2009) that followed.

In parallel with these activities, the OECD, in collaboration with the World Bank, is building an Innovation Policy Platform (IPP)[3] to provide information on innovation policies, their implementation and other innovation activities in member and observer countries. As the IPP develops, and is used, it will have more influence on the development of innovation indicators, especially those that deal with linkages.

Within the United Nations system, there are three initiatives that relate to indicator development and use. The United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute of Statistics (UIS) has released the results[4] of its first collection of innovation indicators from 64 countries. The collection was done in collaboration with the African Union/NEPAD Planning and Coordinating Agency (AU/NPCA), Eurostat, the OECD and RICYT.

In addition, UNESCO has launched the Global Observatory of STI Policy Instruments (GO-SPIN) which has been collecting and standardizing information on innovation systems and policies in member countries. It started with 34 countries in Latin America and the Caribbean (UNESCO 2010) and is now working in Africa to produce a new UNESCO series, the 'GO-SPIN country profile of Science, Technology and Innovation Policies'. The first two volumes cover Botswana (UNESCO 2013) and Zimbabwe (UNESCO 2014) and one on Malawi is expected to follow in September 2014. The UNESCO work in Africa is done in collaboration with the Africa Observatory for Science, Technology and Innovation (AOSTI), which is a programme of the African Union.

The United Nations University – Maastricht Economic and social Research and training institute on Innovation and Technology (UNU-MERIT) has, for some years, been providing the Design and Evaluation of Innovation Policy (DEIP) course to countries that request it. In October 2014, a DEIP course is planned in Nairobi, in collaboration with the African Union Commission, for participants from countries in three African Regional Economic Communities. The development and presentation of the course is managed with AOSTI and the venue is provided by the East Africa node of the Pan African University (PAU). This is a first step towards AOSTI offering its own version of the DEIP course in other regions of Africa.

Participants in the DEIP course in Nairobi are expected to gain an appreciation of innovation indicators, their development, and use in Africa and to find a set of indicators that fits the economic, social and policy context in which they work. This is part of a discussion of the use of indicators in development that has been going on for some time (World Bank 2010)

All of these activities are going to raise questions about innovation indicators and how they are going to be used to support the development of innovation policy and to evaluate policy implementation in ways that are internationally comparable. In addition

[3] See https://www.innovationpolicyplatform.org/
[4] See http://www.uis.unesco.org/ScienceTechnology/Pages/innovation-data-release.aspx

to initiatives from international organizations, countries have committed resources to understanding innovation policy and related indicators. Several were mentioned in Section 3 and a new initiative is the Centre of Excellence in Scientometrics and Science, Technology and Innovation Policy (SciSTIP) at the University of Stellenbosch in South Africa (http://www.sun.ac.za/scistip) which is developing a research programme on indicators and their application. While there is emphasis on scientometrics, work is also planned on innovation indicators and policy.

The next few years should see revisions of the manuals that govern the subject, and more countries conducting innovation surveys and using the results to inform policy development and its evaluation. This should lead to a better understanding of systems of innovation and how policy can be used to achieve government objectives locally and to address challenges globally. This is not a closed process as the OECD Working Party of National Experts on Science, Technology Indicators (NESTI) involves the 34 member countries of the OECD, the European Commission, observer countries, including Brazil, China, India, Russia and South Africa, and observer organizations such as the African Union, the UNESCO Institute of Statistics (UIS) and RICYT. Delegates from observer countries and organizations are expected to be an integral part of the process of developing innovation indicators.

Acknowledgement

This paper results from a presentation and discussion at the conference on *Science, Technology and Innovation Indicators in Ibero America: Present outlook and future prospects* held in Bogota, October 10, 2013. The support of RICYT is acknowledged as are the contributions of the participants in the session where the presentation was given.

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